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Herbicide Evaluation Studies with Celery (*Apium graveolens* var. *dulce*), Lettuce (*Lactuca sativa*), and Crucifers (*Brassica* spp.) in Hawaii

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INTRODUCTION

The chemical weeding of vegetable crops is rapidly becoming an important new cultural tool of interest to many island farmers. An increasing labor shortage on the island farms has contributed to an intense awareness by farmers of the role of chemical weed control in the immediate future. The "leafy green" and "cole" crops comprise an important segment of the vegetable industry in Hawaii. These crops require many hours of hand labor and tractor cultivation to remove the weeds. The studies reported herein were conducted to determine the feasibility of using herbicides to supplement or replace the present-day methods of weed control.

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Celery (*Apium graveolens* var. *dulce*), lettuce (*Lactuca sativa*), and several members of the Cruciferae family were tested under similar conditions because of their related ecological requirements. The Cruciferae under test were: broccoli (*Brassica oleracea* var. *italica*), cauliflower (*Brassica oleracea* var. *botrytis*), head cabbage (*Brassica oleracea* var. *capitata*), Chinese cabbage (*Brassica pekinensis*), white mustard cabbage (*Brassica chinensis*), green mustard cabbage (*Brassica juncea*), and daikon (*Raphanus sativus* var. *longipinnatus*).

Several herbicides, representing a diversity of chemical structures, were evaluated because previous experiments have shown that the herbicides presently available for use are only partially effective under island conditions. Many of the chemicals tested are either registered with the Federal Food and Drug Administration for use with vegetable crops in the United States or appear to be likely candidates for future registration with the crops under test. Some chemicals were selected because they provide commercially acceptable weed control under island conditions, but the crop selectivities have not been thoroughly evaluated.

MATERIALS AND METHODS

The herbicide trials were conducted at four test locations which represent a wide range of ecological and edaphic conditions in the crop-producing areas (Table 1). The two high-elevation Branch Experiment Stations, Lalamilo and Kula, are centered in the major lettuce-, celery-, head cabbage-, and cauliflower-growing areas. Soil types, climatic conditions, and weed species are very similar for the two areas irrespective of their differing island locations. It should be noted that these two locations have several hard-to-kill weed species which are common to those found in many temperate regions. The soil is relatively high in organic matter (8.5 9%) which undoubtedly contributes to the unexpected results often obtained in the test plots. The Waimanalo Experimental Farm is located on a montmorillonite type clay which contains 3 to 4% organic matter. The weed species are similar to those found in subtropical and temperate climatic zones.

The crops tested and their respective experimental locations are contained in Table 2.

TABLE 1. Description of the Test Locations

Experiment Station	Island	Elevation (feet)	Soil Type	Median Annual Rainfall (inches)
Lalamilo Branch Station	Hawaii	2,650	Waimea loam	25
Manoa Campus Farm	Oahu	90	Manoa clay loam	35
Kula Branch Station	Maui	3,200	Waimea (Kula) loam	28
Waimanalo Experimental Farm	Oahu	70	Waimanalo silty clay	45

TABLE 2. Herbicide Experiments and Test Locations

Experiment No.	Crops Tested	Location
1 and 2	Broccoli 'Green Bud,' Cauliflower 'Puakea,' and Head Cabbage 'Copenhagen Market'	Waimanalo Experimental Farm
3 and 4	Cauliflower 'Early Snowball' and Head Cabbage 'Copenhagen Market'	Kula Branch Station
5	Celery 'Utah 15' and 'Utah 52-70'	Waimanalo Experimental Farm
6	Celery 'Utah 15' and 'Utah 52-70'	Lalamilo Branch Station
7	Celery 'Spartan'	Lalamilo Branch Station
8	Lettuce 'Green Mignonette,' Green Mustard Cabbage 'Kai Choi,' White Mustard Cabbage 'Pak Choi,' and Chinese Cabbage 'Won Bok'	Waimanalo Experimental Farm
9 and 10	Lettuce 'Early Great Lakes' and Chinese Cabbage 'Nagaoka 60 days'	Lalamilo Branch Branch Station
11	Lettuce 'Early Great Lakes'	Lalamilo Branch Station
12	Chinese Cabbage 'Nagaoka 60 days'	Lalamilo Branch Station
13	Daikon 'Minoyonbai-Long' and 'Chinese Half-Long'	Lalamilo Branch Station
14	Lettuce 'Green Mignonette'	Manoa Campus Farm

Cultural Practices

The cultural practices conformed to those commonly in use by island farmers. Overhead irrigation was applied at the discretion of the farm manager.

A weed-free "cultivated check" was maintained as standard practice in each experiment by shallow cultivation. An attempt was made to remove excessive weed growth in all treatments whenever a crop x weed interaction was anticipated.

Treatment Applications

Commercial formulations of the herbicides were used in the experiments (Table 3). The chemicals were dissolved or suspended in water and the field spray mix applied at the rate of 40 gal/acre with a back-mounted fiberglass sprayer which was operated at 30 p.s.i. (pounds per square inch of pressure). Granular formulations were applied with either a hand cyclone seeder or a hand-operated Gandy machine. Certain treatments were applied before the crops were transplanted or sown and immediately incorporated into the topsoil with a hand-operated motor-driven tillivator. This treatment is referred to as "soil incorporated." A majority of the direct-seeded crops were sprayed immediately after seed sowing and the transplanted crops received either over-the-plant or directed sprays shortly after transplanting. The method of application and treatment dates are described in the Appendix on a per-experiment basis.

Methods of Evaluating and Reporting the Experimental Results

The crop and weed responses to the herbicides were evaluated primarily with the use of the following subjective rating system:

Weed Control Ratings	*Crop Tolerance Ratings*
1—no control	1—no injury
2—slight control	2—slight injury
3—fair control	3—moderate injury
4—good control—commercially acceptable	4—severe injury
5—complete control	5—dead

The procedure for the subjective rating was to study all of the check plots in an experiment before the evaluations were made; subsequently, the plots

TABLE 3. Chemicals Used in the Experiments

Trade Name[1]	Registered for Use on the Following Crops[2]	Temporary Designation or Common Names	Chemical Name
Amiben		amiben	3-amino-2,5-dichlorobenzoic acid
Balan	Lettuce	benefin	N-butyl-N-ethyl- $\alpha\alpha\alpha$ -trifluoro-2,6-dinitro-p-toluidine
Caparol		prometryne	2,4-bis(isopropylamino)-6-methylmercapto-s-triazine
Chloro-I.P.C.	Broccoli, Cabbage, Celery, Lettuce, Radish	C.I.P.C.	isopropyl-N-(3-chlorophenyl)carbamate
Dacthal W-75	Broccoli, Cauliflower, Cabbage, Lettuce, Mustard Greens	DCPA, DAC 893	dimethyl ester of tetrachloro-terephthalic acid
Dow Sodium TCA	Cabbage, Cauliflower	TCA	trichloroacetic acid
Dymid	Cabbage	diphenamid	N,N-dimethyl-2,2-diphenylacetamide
Herban		norea	3-(hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea
I.P.C.	Broccoli, Cabbage, Cauliflower, Celery, Lettuce, Radish	I.P.C.	isopropyl N-phenyl-carbamate
Lorox		linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
Prefar		bensulide, R-4461	N-(2-mercaptoethyl)-benzenesulfonamide

(Continued)

TABLE 3. Chemicals Used in the Experiments (Continued)

Trade Name	Registered for Use on the Following Crops	Temporary Designation or Common Names	Chemical Name
		R-7465	2-(α-naphtoxy)-N,N-diethylpropionamide
Randox	Cabbage	CDAA	2-chloro-N,N-diallyl-acetamide
Sinox PE		DNBP, amine	4,6-dinitro-o-sec-butylphenol (triethanolamine salt)
Stoddard Solvent	Broccoli, Cabbage, Cauliflower, Celery, Lettuce	Petroleum solvent	
Tenoran		Chloroxuron	3[p-(p'chlorophenoxy)-phenyl]-1,1-dimethylurea
TOK E-25		FW-925	2,4-dichlorophenyl-4-nitrophenylether
Treflan	Broccoli, Cabbage, Cauliflower	trifluralin	2,6-dinitro-N,N-di-n-propyl-ααα-trifluoro-p-toluidine
Trefmid W-50		diphenamid plus trifluralin	
Vegadex	Broccoli, Cabbage, Cauliflower, Celery, Lettuce, Mustard Greens	CDEC	2-chloroallyl diethyldithio-carbamate

[1]Active ingredients of chemical formulations: Emulsifiable concentrates (pounds per gallon)—Balan, 1.5; Amiben and TOK, 2.0; Sinox PE, 3.0; Chloro-I.P.C., Prefar, Randox, Treflan, and Vegadex, 4.0.

Wettable Powders: Caparol, 80%; Dacthal, 75%; Dow Sodium TCA; 94%; Dymid, 80%; Herban, 80%; I.P.C., 75%; Lorox, 50%; R-7465, 50%; Tenoran, 50%; and Trefmid, 50% (Treflan 10%—Dymid 40%).

Granulars: Amiben, 10.8; Randox and Vegadex, 20%; and Treflan, 5%.

[2]Registrations obtained from U.S.D.A. Summary of Registered Agricultural Pesticide Chemical Uses (2nd Edition), July 1, 1964,

were rated without knowledge of the treatment. This unbiased method often resulted in check plot ratings greater than "1." If more detailed data were thought necessary, a stand count was made to measure the weed control activity; similarly, crop yields were recorded when desired. Table 4 contains a listing of the weed species which were present in sufficient numbers to be evaluated.

All data are reported in the Appendix as treatment means. The L.S.D. (least significant difference) was selected as the main statistic for ease of comparing treatment means. It was used largely to compare the herbicide treatment means to the cultivated check when considering crop tolerance and to the uncultivated check when interpreting weed response. The data are presented in Appendix form to allow for careful scrutiny by interested parties. It is assumed that the General Results and Discussion sections will provide ample information for many users of this report.

TABLE 4. Scientific Names of the Weed Species Discussed in this Report

Common Names (Hawaiian Islands)	Scientific Names
Grasses	
foxtail, bristly	*Setaria verticillata*
kikuyu	*Pennisetum clandestinum*
ricegrass, jungle	*Echinochloa colonum*
wiregrass	*Eleusine indica*
Broadleaves	
amaranth, spiny	*Amaranthus spinosus*
amaranth (spineless species)	*Amaranth* spp.
popolo	*Solanum nodiflorum*
purslane (pigweed)	*Portulaca oleracea*
sorrel, yellow flower	*Oxalis corniculata*
swinecress	*Coronopus didymus*

RESULTS

The results show that there are distinct possibilities for expanding the use of herbicides on the crops tested in the experiments. Table 5 contains general descriptive crop phytotoxicity information which was compiled from the detailed experimental results presented in the Appendix. A general summary of the weed response data is presented in Table 6. The standard test herbicide, Vegadex, provided commercially acceptable weed control for periods of 4 to 6 weeks in many of the experiments. Its margin of safety on all of the test crops was commercially acceptable. When considering both crop phytotoxicity and general weed control, Dacthal can be used advantageously under island conditions for several "leafy green" and "cole" crops. Caparol appears to be an excellent candidate for weed control in celery and the satisfactory weed control with TOK suggests the need for further experimentation with this compound in celery and *Brassica* spp. Two new herbicides, Balan and Prefar, did not provide commercially acceptable control under the test conditions.

It should be noted that celery was tolerant to over-the-plant sprays of many potentially useful herbicides. A single experiment indicated that daikon (Japanese radish) was tolerant to a wide array of herbicide chemistry. The tolerance of swinecress to several herbicides was discouraging since it is an important weed in most vegetable-growing areas.

DISCUSSION AND SUMMARY

The experimental results show that Dacthal and Vegadex should be considered as the two primary herbicides for use with lettuce, head cabbage, broccoli, cauliflower, white and green mustard cabbage, and Chinese cabbage in Hawaii. Treflan can be used to advantage for weed control in head cabbage, cauliflower, and broccoli, but its poor control of swinecress and other broadleaved weeds in Hawaii will undoubtedly limit its use. Table 7 gives the recommended procedures for using the herbicides under Hawaiian conditions. Although Vegadex and petroleum solvents are the only two recommended herbicides for present use in celery, the experimental results indicate that some excellent herbicides will be available for use with celery in the future. Similarly, the results show that the *Brassica* spp. are tolerant to a broad spectrum of new herbicides. From all indications, the needed improvement in lettuce weed control in Hawaii will require continued research to find more satisfactory herbicides. The two new herbicides, Balan and Prefar, which have been reported to control weeds in some of the mainland U. S. lettuce-growing areas, have performed poorly on the soil types which are commonly used for growing lettuce in Hawaii.

TABLE 5. Crop Tolerance to the Herbicides[1]

Herbicide	Crop Tolerance
Amiben	Severe injury to broccoli (1), cauliflower (1,3), and head cabbage (1,4) at 4 lb/acre. No injury to celery (6) when applied over the transplanted crop.
Balan	No injury to celery (7), lettuce (11, 14), and Chinese cabbage (12) when used as a preplant soil incorporated treatment at 2½ lb/acre.
Caparol	Celery (5,6,7) was not injured in three experiments when applied as an over-the-plant spray immediately after transplanting. No injury to two varieties of daikon (13) as a pre-emergence spray.
C.I.P.C.	No injury to celery (7) when applied alone or in combination with Vegadex as an over-the-plant spray. Green Mignonette lettuce (8) and head lettuce (11) were not injured when used as a pre-emergence spray. Kai Choi was severely injured as compared to slight to moderate injury to Pak Choi and Won Bok at the Waimanalo Experimental Farm (8).
Dacthal	No injury to broccoli, cauliflower, and head cabbage (1,2,3,4) as either a directed or over-the-plant spray. Celery (5,6) exhibited no evidence of injury with an over-the-plant spray at 10.5 lb/acre. Moderate to severe injury to lettuce (9,11) when sprayed immediately after seed sowing, but no injury detected as an over-the-plant spray 2 weeks after sowing. No injury to Chinese cabbage (10,12) and daikon (13) as a pre-emergence spray.
Dow Sodium TCA	No significant yield reductions with broccoli and cauliflower as a directed spray at 6 lb/acre. A slight reduction in the plant weight of head cabbage (1).
Dymid	Severe injury to cauliflower and head cabbage (3,4). No injury as a pre-emergence spray on lettuce (9), Chinese cabbage (10), and daikon (13). No injury to celery (6) when sprayed immediately after transplanting.
Herban	No reduction in celery (6) yield at 2 lb/acre.
I.P.C.	No injury to lettuce (9) and Chinese cabbage (10) as a pre-emergence spray.
Lorox	Severe injury to daikon at the Lalamilo Branch Station (13).
Prefar	No injury to celery (6), lettuce (9,11), and Chinese cabbage (10) when preplant soil incorporated.
R-7465	No injury to celery (7) and Chinese cabbage (12).
Randox	Moderate to severe injury on broccoli (1,2), head cabbage (1,2,4), and cauliflower (1,3) as a liquid spray, but no injury when granulars were applied over broccoli (2), head cabbage (1,2,4), and cauliflower (2).
Sinox PE	Moderate injury when used pre-emergence in daikon (13).
Stoddard Solvent	No injury to celery (6,7) when sprayed over the plants 2 weeks after transplanting.

(Continued)

TABLE 5. Crop Tolerance to the Herbicides[1] (Continued)

Herbicides	Crop Tolerance
Tenoran	No injury to celery (6) as an over-the-plant spray immediately after transplanting.
TOK E-25	No injury as an over-the-plant spray on celery (6,7) at 2 weeks. Severe injury to Chinese cabbage (10) as a pre-emergence spray.
Treflan	No injury to broccoli (1), head cabbage (1,4), and cauliflower (1) when applied as directed and over-the-plant sprays at 4 to 6 lb/acre. Moderate injury to cauliflower (3) at the high-elevation Kula Branch Station. Celery (6) tolerated 2 lb/acre soil incorporated before transplanting. Lettuce (9,11,14) injury varied from slight to moderate under the test conditions. Chinese cabbage (10) and daikon (13) were tolerant to soil-incorporated rates of 2 lb/acre.
Trefmid	Lettuce (9) and Chinese cabbage (10) were not injured with 7 lb/acre incorporated before seed sowing.
Vegadex	Vegadex was used as a standard herbicide in all of the experiments. Granular formulation was non-injurious to cauliflower (1,2,3), broccoli (1,2), and head cabbage (1,2,4). Vegadex liquid sprays caused slight injury to head cabbage (1) and broccoli (2). Celery was not injured by over-the-plant sprays in three experiments (5,6,7). Lettuce (8,9,11,14), Chinese cabbage (8,10,12), green and white mustard cabbage (8), and daikon (13) were not injured by pre-emergence spray applications.

[1] The numbers in parentheses refer to the experiment from which the results were summarized.

TABLE 6. Pre-emergence Control of the Prevalent Weed Species Encountered in the Experiments[1]

Herbicide	Grasses				Broadleaves		
	Foxtail	Kikuyu	Rice-grass	Wire-grass	Amaranth spp.	Purslane	Swine-cress
Amiben	S	S	S	S	S	S	I-S
Balan				I	I	I	I
Caparol		S	S	S	S	S	S
C.I.P.C.				I	I	I	I
Dacthal	S	T-I	S	I-S	S	S	T-I
Dow Sodium TCA	S		S	I	T	T	
Dymid		I-S			S	I-S	I-S
Herban		S			I	S	S
I.P.C.		T-I			T-I	S	T-I
Lorox					S	S	
Prefar		I			T	T	T
R-7465					I-S	I-S	T-I
Randox	S		S	S	S	S	I
Sinox PE					I	I	
Stoddard Solvent		S			S	S	S
Tenoran		I			S	S	S
TOK E-25		S			S	S	S
Treflan		I-S		S	S	S	I
Trefmid		I			S	S	T-I
Vegadex	I-S	T-I	I-S	S	I-S	S	I-S

[1]Weed Tolerance: T—Tolerant to herbicide; I—Intermediate (often influenced by soil type); S—Susceptible.

TABLE 7. Recommended Herbicides for Trial Use

Herbicide (pounds active/acre)	Time of Application	Broccoli, Cauliflower, Head Cabbage	Celery	Lettuce	Chinese Cabbage, Mustard Greens
Dacthal 6 to 10½ lb.	Pre-emergence to crop and weeds.				+
	Post-emergence to crop and pre-emergence to weeds.	+		+	
Petroleum solvents 40 to 100 gal.	Post-emergence to crop and small weeds.		+		
Treflan 1 lb.	Preplant soil incorporated.	+			
Vegadex 4 to 6 lb.	Pre-emergence to crop and weeds.			+	+
	Post-emergence to crop (granular formulation preferred) and pre-emergence to weeds.	+	+		

RELATED LITERATURE

1. Nakagawa, Y., and R. R. Romanowski, Jr. 1963. Chemical weed control in vegetable crops. Hawaii Cooperative Extension Service, Circular 402. 16 pp.

2. Romanowski, R. R., Jr., J. S. Tanaka, D. L. Plucknett, and D. D. F. Williams. 1963. Tomato (*Lycopersicon esculentum*) herbicide screening trials in Hawaii. Hawaii Agricultural Experiment Station. Technical Progress Report No. 138. 25 pp.

3. Romanowski, R. R., Jr., and Y. Nakagawa. 1965. Current status of chemical weed control with vegetable crops. *Hawaii Farm Science*, Vol. 14, No. 1, pp. 6–9.

4. Romanowski, R. R., Jr., and J. S. Tanaka. 1965. An evaluation of herbicides for use with cucumbers (*Cucumis sativus*) and watermelons (*Citrullus vulgaris*) in Hawaii. Hawaii Agricultural Experiment Station. Technical Progress Report No. 144. 32 pp.

5. Romanowski, R. R., Jr., and J. S. Tanaka. 1965. Secondary herbicide screening trials with leguminous vegetable crops in Hawaii. Hawaii Agricultural Experiment Station. Technical Progress Report No. 146. 23 pp.

APPENDIX

EXPERIMENT NO. 1

(Permanent file copy WC–15)
Waimanalo Experimental Farm Field P–2

Crops:	Broccoli 'Green Bud,' Cauliflower 'Pua Kea,' and Head Cabbage 'Copenhagen Market.'
Experimental design:	Randomized complete block, 3 replications, split plot arrangement of treatments–herbicides 5 ft. x 27 ft., 6 plants per subplot.
Experimental procedure:	Field preparation July 23, 1962; Field transplanting July 23; Treatment application July 25.
Climatic conditions:	*Rainfall (over .1 inch)*: July 22–.14 inch, 31–1.8, August 13–.13.
	Irrigation (Overhead): July 23, 25, 27, 30, August 3, 6, 10, 13, 15, 17, 20.
Results:	See Tables A-1-1 and A-1-2.

Discussion and Summary:

Crop tolerance: Dacthal and Vegadex (granular formulation) were nontoxic to the test crops. Vegadex at 6 lb/acre (spray formulation) was injurious to head cabbage; whereas, Randox (spray formulation) and Amiben were toxic to all crop species. Granular Randox was safe on cabbage.

Weed control: Amiben, Dacthal, Randox, and Vegadex 6 lb/acre (spray formulation) provided commercially acceptable weed control of the weed species. TCA and Vegadex spray at the low rate as well as the granular formulation did not perform satisfactorily on all weed species.

TABLE A-1-1. Crop tolerance to the herbicides,
Waimanalo Experimental Farm, Experiment No. 1

Treatment (pounds active per acre)	August 23 (4 weeks)					
	Average number of plants/plot			Average weight of plants/plot (lb)		
	Broccoli	Cauliflower	Head Cabbage	Broccoli	Cauliflower	Head Cabbage
1. Check, uncultivated	5.0	6.0	5.0	3.3	3.9	3.5
2. Check, cultivated	5.7	5.7	5.3	7.1	5.9	4.6
3. Vegadex 4 lb. directed spray	5.7	5.7	5.7	6.7	6.9	7.4
4. Vegadex 6 lb. directed spray	5.0	6.0	4.3	6.9	7.0	3.2*
5. Vegadex 6 lb. over-plant spray	5.0	6.0	2.7**	7.6	7.5	2.9**
6. Vegadex 6 lb. over-plant granular	5.7	6.0	5.7	6.7	5.1	4.7
7. Randox 6 lb. directed spray	5.7	6.0	2.7**	5.0**	5.0*	2.2**
8. Randox 6 lb. over-plant spray	3.7**	6.0	4.7	3.9**	5.4	2.0**
9. Randox 6 lb. granular	6.0	5.7	5.0	5.6*	4.2*	4.1
10. Dacthal 6 lb. directed spray	5.7	5.7	5.3	7.8	5.7	5.3
11. Dacthal 9 lb. directed spray	6.0	6.0	5.7	9.0	5.8	5.8
12. Amiben 4 lb. directed spray	5.0	6.0	2.0**	2.4**	1.7**	0.4**
13. TCA 6 lb. directed spray	5.3	6.0	4.7	6.5	6.8	3.5*
L.S.D. 5% (1%)	1.3(1.8)	n.s.	1.3(1.8)	0.9(1.9)	0.9(1.9)	0.9(1.9)

*Significantly different from the cultivated check at the 5% level (**1% level).

TABLE A-1-2. Weed control response to the herbicides, Waimanalo Experimental Farm, Experiment No. 1

Treatment (pounds active per acre)	August 14 Number of weeds per square foot[1]				
	Rice-grass	Wire-grass	Foxtail	Purslane (Pigweed)	Smooth Amaranth
1. Check, uncultivated	22.2	21.3	5.0	2.5	3.2
2. Check, cultivated	2.9	2.2	0.4	0.1	1.0
3. Vegadex 4 lb. directed spray	2.2	0.4	0.9	0.8	2.1
4. Vegadex 6 lb. directed spray	0.9	0.1	0.3	0.0	0.0
5. Vegadex 6 lb. over-plant spray	1.4	0.3	0.4	0.0	0.2
6. Vegadex 6 lb. over-plant granular	7.8	3.4	1.5	0.0	0.3
7. Randox 6 lb. directed spray	0.0	0.0	0.0	0.0	0.0
8. Randox 6 lb. over-plant spray	0.0	0.0	0.0	0.0	0.0
9. Randox 6 lb. granular	0.1	0.1	0.0	0.1	0.0
10. Dacthal 6 lb. directed spray	0.1	0.1	0.0	0.0	0.0
11. Dacthal 9 lb. directed spray	0.2	0.9	0.2	0.0	0.0
12. Amiben 4 lb. directed spray	0.0	0.0	0.0	0.0	0.0
13. TCA 6 lb. directed spray	0.9	3.3	0.1	1.8	3.1
L.S.D. 5% (1%)	4.6(6.2)	4.4(5.9)	1.5(2.0)	1.1(1.4)	2.1(2.8)

[1] An average of 4 readings per plot.

EXPERIMENT NO. 2

(Permanent file copy WC–21)
Waimanalo Experimental Farm Field C–2

Crops:	Broccoli 'Green Bud,' Cauliflower 'Pua Kea,' Head Cabbage 'Copenhagen Market.'
Experimental design:	Randomized complete block, 3 replications, split plot arrangement of treatments–herbicides 5 ft. x 36 ft., 8 plants per subplot.
Experimental procedure:	Field preparation October 16, 1962; Field transplanting October 17; Treatment application October 18.
Climatic conditions:	*Rainfall (over .1 inch)*: October 17–.64 inch, 19–.12, 20–.68, 21–.48, 22–.93, 23–.14, Nov. 19–.1 inch.
	Irrigation (Overhead): October 31, November 9, 14, 19, 21.
Weed species:	Most prevalent: *grass*–wiregrass; *broadleaves*–spiny amaranth, purslane (pigweed), popolo.
Results:	See Table A-2.

Discussion and Summary:

Crop tolerance: The cauliflower growth was not affected by the herbicides, and the spray formulation of Randox was the only treatment which injured head cabbage. Granular Randox did not injure the 3 crop species. Vegadex and Randox were toxic to broccoli when sprayed over the plants. As in Experiment No. 1, Vegadex (granular formulation) and Dacthal were satisfactory when used on the 3 crop species. Treflan exhibited good selectivity on the crops tested.

Weed control: Treflan, Vegadex, and Dacthal (high rate) controlled the weeds satisfactorily. Randox was more toxic to wiregrass than Dacthal (low rate); nevertheless, Dacthal was superior on the broadleaved weeds.

TABLE A-2. Crop tolerance and weed control rating to the herbicides, Waimanalo Experimental Farm, Experiment No. 2

Treatment (pounds active per acre)	Crop Response — November 23 Total Fresh Weight/Plant (lb/plot)			Weed Control — November 8 Weed Rating[1]	
	Head Cabbage	Broccoli	Cauliflower	Grasses	Broadleaves
1. Check, uncultivated	4.9	4.9	4.6	1.0	1.0
2. Check, cultivated	7.1	7.1	4.1	5.0	5.0
3. Vegadex 6 lb. directed spray	8.7	7.0	6.8**	4.7	4.0
4. Vegadex 6 lb. over-plant spray	7.4	4.4**	6.3*	4.7	5.0
5. Vegadex 6 lb. over-plant granular	7.8	8.9	8.8**	4.0	4.3
6. Randox 6 lb. directed spray	4.4**	5.0*	5.0	3.3	3.3
7. Randox 6 lb. over-plant spray	3.3**	2.6**	3.9	4.0	3.3
8. Randox 6 lb. granular	8.8	6.5	5.9	4.3	3.7
9. Dacthal 6 lb. directed spray	7.8	7.3	8.1**	3.7	4.7
10. Dacthal 6 lb. over-plant spray	7.9	5.6	8.1**	3.3	4.7
11. Dacthal 9 lb. directed spray	8.9	4.0**	5.1	4.3	5.0
12. Dacthal 9 lb. over-plant spray	8.3	8.7	8.5**	4.3	5.0
13. Treflan 6 lb. directed spray	6.9	6.3	6.1*	5.0	5.0
14. Treflan 6 lb. over-plant spray	8.3	5.6	8.2**	5.0	5.0
L.S.D. 5% (1%)	2.0(2.7)	2.0(2.7)	2.0(2.7)	0.9(1.2)	0.9(1.2)

[1]Weed Rating: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete control.
*Significantly different from the uncultivated check at the 5% level (**1% level).

EXPERIMENTS NOS. 3 and 4

(Permanent file copy WC–37H)
Kula Branch Station, Kula, Maui

Crops:
Expt. No. 3 Cauliflower 'Early Snowball.'
Expt. No. 4 Head Cabbage 'Copenhagen Market.'

Experimental design: Randomized complete block, 3 replications, plot size 3 ft. x 27 ft. (18 plants) for each experiment.

Experimental procedure: Field preparation–March 30, 1963; Field transplanting–April 1 and 2; Treatment applications April 3 and 4.

Climatic conditions: *Rainfall (over .1 inch)*: April 2–.20 inch, 6–.50, 7–.25, 9–.46, 10–.27, 11–.56, 14–.61, 15–.90, 17–.46, 18–.22, 27–.23, 28–.58, 29–.44, May 5–1.06, 15–2.00, 16–1.39, 17–.74, 19–.34.

Irrigation (Overhead): April 4–.5 inch.

Results: See Table A-3 (& 4).

Discussion and Summary:

Crop tolerance: Dacthal, Treflan, and Vegadex showed a good margin of crop tolerance on head cabbage and cauliflower. The "soil incorporated" Treflan exhibited a slight reduction in cauliflower weight compared to no reduction with the surface treatments. Amiben, Dymid, and Randox injured the cauliflower; however, a directed spray of Dymid and the granular formulation of Randox were acceptable on head cabbage.

Weed control: Vegadex, Treflan (high rate), and Dymid all showed commercially acceptable control of swinecress.

TABLE A-3 (& 4). Crop tolerance and weed response to the herbicides, Kula Branch Station, Kula, Maui, Experiments Nos. 3 and 4

Treatment (pounds active per acre)	May 9 Crop Rating[1] Expt. 3 Cauli-flower	May 9 Crop Rating[1] Expt. 4 Head Cabbage	June 28 Yield Data Cauliflower No. of heads/plot	June 28 Yield Data Cauliflower Average weight /head	June 29 Yield Data Head Cabbage No. of heads/plot	June 29 Yield Data Head Cabbage Average weight /head	May 9 Weed Rating[2] Expt. 3 Swine-cress
1. Check, uncultivated	2.0	1.3	12.0	0.5 lb.	15.7	1.9 lb.	1.7
2. Check, cultivated	1.3	1.7	12.0	0.6	14.3	2.2	5.0
3. Vegadex 6 lb. over-plant spray	1.3	1.7	10.7	0.6	14.0	1.9	4.3
4. Vegadex 6 lb. directed spray	2.3**	1.7	13.7	0.5	12.0	2.3	4.0
5. Vegadex 6 lb. over-plant granular	1.0	1.3	11.0	0.6	14.7	2.3	5.0
6. Randox 6 lb. over-plant spray	3.3**	3.0**	7.0*	0.3**	10.7*	2.3	3.0
7. Randox 6 lb. granular	2.7**	2.0	12.0	0.4*	12.7	2.0	3.3
8. Dacthal 10½ lb. directed spray	1.3	1.3	11.7	0.6	14.7	2.1	3.3
9. Dacthal 10½ lb. over-plant spray	2.0*	1.3	12.0	0.5	12.7	2.1	3.3
10. Treflan 4 lb. granular	2.7**	1.7	12.7	0.5	14.3	2.3	5.0
11. Treflan 2 lb. granular (soil incorporated)	3.0**	2.7**	12.0	0.4*	14.0	2.2	3.3
12. Treflan 4 lb. directed spray	2.0*	1.3	10.7	0.5	13.7	2.4	3.7
13. Treflan 4 lb. over-plant spray	3.3**	2.0	8.3	0.5	12.3	2.3	4.7
14. Dymid 6 lb. directed spray	3.3**	1.7	8.0	0.4*	13.0	1.7	3.7
15. Dymid over-plant spray	4.0**	3.3**	1.0**	0.1**	8.3**	2.2	4.7
16. Amiben 4 lb. granular	3.3**	4.0**	8.3	0.4*	9.0**	1.9	2.7
L.S.D. 5%	0.7	0.7	4.1	0.17	2.7	n.s.	0.7
L.S.D. 1%	1.0	1.0	5.5	0.22	3.7		1.0

[1]Crop Rating Scale: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead.

[2]Weed Rating Scale: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete control.

*Significantly different from the cultivated check at the 5% level (**1% level).

EXPERIMENT NO. 5

(Permanent file copy WC–32)
Waimanalo Experimental Farm Field R–1

Crop:	Celery 'Utah 15' and 'Utah 52-70.'
Experimental design:	Randomized complete block, 4 replications. Split plot arrangement of treatments–herbicides 5 ft. x 30 ft., 15 plants per subplot.
Experimental procedure:	Field preparation December 28, 1962; Field transplanting December 28; Treatment applications January 19, 1963 as over-the-plant sprays.
Climatic conditions:	*Rainfall (over .1 inch)*: January 16–1.90 inch, 19–.26, 21–1.42, 22–1.36, 23–.19, 25–.86, 26–.32, 27–.10, 28–.10, 29–.08, 30–1.10, 31–.30, February 5–.17, 6–.10, 7–.17, 9–.18, 10–.28, 12–1.42, 17–.29, 19–.59, 28–4.47, March 1–2.60, 5–.18, 6–2.69, 17–.88.
Weed species:	Most prevalent: *grasses*–wiregrass, ricegrass; *broadleaves*–spiny amaranth.
	Trace amounts: *broadleaves*–oxalis, popolo, swinecress.
Results:	See Table A-5.

Discussion and Summary:

Crop tolerance: All of the herbicides merit further consideration as possible celery herbicides because of the acceptable crop selectivity.

Weed control: Caparol and Randox performed admirably for a period of 2 months under excessive rainfall conditions.

TABLE A-5. Crop tolerance and weed control ratings to herbicides, Waimanalo Experiment Station Experiment No. 5

Treatment (pounds active per acre)	April 24 Average weight/plant (lb)		March 14 Weed Rating[1]	
	Utah 15	Utah 52-70	Grasses	Broadleaves
1. Check, uncultivated	0.9	1.2	1.0	1.0
2. Check, uncultivated	0.9	1.2	5.0	4.8
3. Vegadex 6 lb.	0.8	0.9	3.5	3.8
4. Randox 6 lb.	0.6	0.8	4.0	4.3
5. Caparol 2 lb.	0.7	1.1	4.5	5.0
6. Caparol 4 lb.	0.6	0.9	5.0	5.0
7. Dacthal 9 lb.	0.8	1.4	3.3	3.3
L.S.D. 5% (1%)	n.s.	n.s.	0.7(0.9)	0.7(0.9)

[1]Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete control.

EXPERIMENT NO. 6

(Permanent file copy WC–63A)
Lalamilo Branch Station

Crop: Celery 'Utah 15' and 'Utah 52-70.'

Experimental design: Randomized complete block, 4 replications, split plot arrangement of treatments–herbicides 2½ ft. x 30 ft., 15 plants per subplot.

Experimental procedures: Field preparation June 22, 1964; Field transplanting June 25; Treatment applications–Prefar and Treflan incorporated into soil June 24, all other initial over-the-plant treatment applications June 25. Treatments 12, 13, and 14 applied over-the-plants on July 7.

Climatic conditions: *Rainfall (over .1 inch)*: July 2–.1 inch, 15–.2, 20–.2, 21–.2, 22–.1, 24–.8, 27–.4, 30–.2.

Irrigation (Overhead): Applied as needed.

Results: See Table A-6.

Discussion and Summary:

Crop tolerance: There was no evidence of celery toxicity from the 11 herbicides evaluated in this experiment. This information is especially encouraging in that, with the exception of Prefar and Treflan the herbicides were sprayed directly over the celery plants.

Weed control: Amiben, Dymid, Caparol, Stoddard Solvent, Tenoran, and TOK E-25 exhibited commercially acceptable control of the weed species. The poor to fair control of swinecress (an important weed species on many vegetable farms) with Dacthal, Prefar, and Treflan was discouraging. The overall poor weed control with Prefar was postulated to be due to the relatively high soil organic matter (9%).

TABLE A-6. Crop tolerance and weed control rating to the herbicides, Lalamilo Branch Station, Experiment No. 6

Treatment (pounds active per acre)	October 1–2 Average Weight/Stalk (lb)		July 24 Weed Rating[1]			
	Utah 15	Tall Utah 52-70	Purslane (Pigweed)	Smooth Amaranth	Swinecress	Kikuyu
1. Check, uncultivated	0.9	1.0	1.0	1.0	1.0	1.5
2. Check, cultivated	1.0	1.1	3.8	3.3	4.0	4.0
3. Vegadex 6 lb.	0.9	1.1	5.0	3.8	4.3	1.3
4. Caparol 4 lb.	1.0	1.0	5.0	5.0	5.0	4.8
5. Amiben 4 lb.	0.9	1.2	5.0	4.8	5.0	5.0
6. Tenoran 6 lb.	0.9	1.2	5.0	5.0	5.0	3.0
7. Dacthal 10½ lb.	0.8	1.0	5.0	4.3	2.3	2.3
8. Dymid 6 lb.	0.9	1.3	4.0	4.5	4.0	4.8
9. Herban 2 lb.	0.9	1.1	5.0	3.8	5.0	4.0
10. Prefar 4 lb. (soil incorporated)	0.9	1.1	1.5	1.0	1.0	2.8
11. Treflan 2 lb. (soil incorporated)	0.8	1.1	4.8	4.0	3.5	5.0
12. Stoddard Solvent 80 gal/acre at 2 weeks	0.8	1.0	5.0	5.0	5.0	5.0
13. TOK E-25 6 lb. at 2 weeks	1.0	1.1	5.0	5.0	4.8	5.0
14. Caparol 4 lb. at 2 weeks	1.0	1.2	5.0	5.0	5.0	5.0
L.S.D. 5% (1%)	n.s.	n.s.	1.0(1.4)	0.9(1.2)	1.2(1.6)	1.4(1.8)

[1] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete control.

EXPERIMENT NO. 7

(Permanent file copy WC–81G)
Lalamilo Branch Station Field 4

Crop:	Celery 'Spartan.'
Experimental design:	Randomized complete block, 4 replications, plot size 4 ft. x 20 ft. (sprayed 2½ ft. x 20 ft.).
Experimental procedure:	Field preparation May 24, 1965; Field transplanting May 26; Treatment applications—Treatment 8 (Balan) incorporated into soil May 26, all initial over-the-plant sprays May 27, Treatments 10, 11, and 12 sprayed over-the-plants on June 10.
Climatic conditions:	*Rainfall (over .1 inch)*: June 4—.16 inch, 6—.1, July 11—.8.
	Irrigation (Overhead): May 27—.5 inch, thereafter applied as needed.
Results:	See Table A-7.

Discussion and Summary:

Crop tolerance: No injury was detected with the entire group of herbicides. This information was very encouraging, especially since the TOK E-25, Prometryne, and Stoddard Solvent were sprayed over the celery plants at 2 weeks.

Weed control: Caparol, TOK E-25, Stoddard Solvent, and R-7465 resulted in commercially acceptable control of the weed species.

TABLE A-7. Crop tolerance and weed control ratings recorded for the various species, Lalamilo Branch Station, Experiment No. 7

Treatments (pounds active per acre)	Crop Rating[1] July 2	Weed Rating[2] July 2	
		Smooth Amaranth	Purslane (Pigweed)
1. Check, uncultivated	1.0	1.0	1.0
2. Check, cultivated	1.0	3.5	3.3
3. Vegadex 6 lb.	1.0	1.0	1.0
4. C.I.P.C. 6 lb.	1.0	1.3	2.8
5. Vegadex 4 lb. + C.I.P.C. 3 lb.	1.0	3.8	5.0
6. Caparol 2 lb.	1.0	4.3	5.0
7. Caparol 4 lb.	1.0	4.3	5.0
8. Balan 2½ lb. (soil incorporated)	1.0	2.3	2.3
9. R-7465 6 lb.	1.0	4.0	4.8
10. TOK E-25 6 lb	1.0	5.0	5.0
11. Stoddard Solvent 80 gal/acre (At 2 weeks)	1.0	4.5	4.3
12. Caparol 4 lb. (At 2 weeks)	1.0	5.0	5.0
L.S.D. 5%	n.s.	0.8	1.1
L.S.D. 1%		1.1	1.5

[1] Crop Rating: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
[2] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete control.

EXPERIMENT NO. 8

(Permanent file copy WC–22)
Waimanalo Experimental Farm Field C–2

Crops: Lettuce 'Green Mignonette,' Green Mustard Cabbage 'Kai Choi,' White Mustard Cabbage 'Pak Choi,' and Chinese Cabbage 'Won Bok.'

Experimental design: Randomized complete block, 3 replications, split plot arrangement of treatments–herbicides 5 ft. x 36 ft., 9 ft. of row per subplot.

Experimental procedure: Field preparation October 16, 1962; Field sowing October 17; Treatment applications–Treatments 3, 5, and 6 on October 18, Treatment 4 after cultivation on November 17.

Climatic conditions: *Rainfall (over .1 inch)*: October 17–.64 inch, 19–.12, 20–.68, 21–.48, 22–.93, 23–.14, November 19–.1.

Irrigation (Overhead): October 31 and November 9.

Weed species: Most prevalent: *grass*–wiregrass; *broadleaves*–spiny amaranth, popolo, purslane (pigweed).

Results: See Table A-8.

Discussion and Summary:

Crop tolerance: Vegadex used as a pre-emergence spray did not injure lettuce and Pak Choi, and only a slight growth reduction was noted with Won Bok and Kai Choi. The results with C.I.P.C. varied from no injury to lettuce to complete eradication of Kai Choi. Pak Choi and Won Bok showed evidence of slight to moderate injury with C.I.P.C. The differing selectivities within the *Brassica* genus are interesting.

Weed tolerance: Vegadex resulted in commercially acceptable control as contrasted to only fair control with C.I.P.C.

TABLE A-8. Crop tolerance and weed control rating to the herbicides, Waimanalo Experimental Farm, Experiment No. 8

Treatment (pounds active per acre)	November 8 Crop Rating[1]				November 26 Weed Rating[2]	
	Lettuce	Kai Choi	Pak Choi	Won Bok	Grass	Broadleaves
1. Check, uncultivated	1.0	1.0	1.0	1.0	2.3	2.3
2. Check, cultivated	1.0	1.0	1.0	1.0	5.0	5.0
3. Vegadex 4 lb.	1.0	2.3**	1.0	1.7*	4.0	4.7
4. Vegadex 6 lb. granular (post-emergence)	1.0	1.0	1.0	1.0	5.0	5.0
5. C.I.P.C. 3 lb.	1.0	5.0**	2.0**	2.0**	3.0	3.0
6. C.I.P.C. 3 lb. + Vegadex 4 lb.	1.0	5.0**	3.0**	3.0**	4.3	5.0
L.S.D. 5% (1%)	n.s.	0.6(0.9)	0.6(0.9)	0.6(0.9)	1.8(2.6)	1.8(2.6)

[1]Crop Rating: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead.
[2]Weed Rating: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete control.
*Significantly different than the cultivated check at the 5% level (**1% level).

EXPERIMENTS NOS. 9 and 10

(Permanent file copy WC–63D and WC–63E)
Lalamilo Branch Station

Crop:
Expt. No. 9 Lettuce 'Early Great Lakes.'
Expt. No. 10 Chinese Cabbage 'Nagaoka 60 days.'

Experimental design: Randomized complete block, 4 replications, plot size 2½ ft. x 30 ft. for each experiment.

Experimental procedure: Field preparation June 22, 1964; Field sowing June 23–25; Treatment applications–Treatments 10, 11, 12, and 13 incorporated into soil June 24, all other treatments applied on June 25.

Climatic conditions: *Rainfall (over .1 inch)*: July 2–.1 inch, 15–.2, 20–.2, 21–.2, 22–.1, 24–.8, 27–.4, 30–.2.

Irrigation (Overhead): Applied as needed.

Results: See Table A-9 (& 10).

Discussion and Summary:

Crop tolerance: The results with Chinese cabbage show that this species exhibits selectivity to many important herbicides. The lettuce injury incurred with Dacthal, TOK E-25, and the high rate of Treflan are of concern.

Weed tolerance: TOK E-25 and Trefmid provided commercially acceptable control of swinecress, and TOK E-25 controlled kikuyu grass from seed. Most herbicides were effective on purslane and smooth amaranth with the exceptions of Dymid and Prefar on purslane and I.P.C. and Prefar on smooth amaranth.

TABLE A-9 (& 10). Crop tolerance and weed control rating to the herbicides, Lalamilo Branch Station, Experiments Nos. 9 and 10

Treatment (pounds active per acre)	July 24 (4 weeks)					
	Crop Rating[1]		Weed Rating[2] (Expt. No. 9)			
	Lettuce	Chinese Cabbage	Purslane (Pigweed)	Smooth Amaranth	Swinecress	Kikuyu
1. Check, uncultivated	1.3	1.0	1.0	1.0	1.0	1.0
2. Check, cultivated	1.8	1.5	4.5	4.8	4.8	4.5
3. Vegadex 4 lb.	2.0	2.0	4.8	4.0	2.8	1.8
4. Vegadex 6 lb.	2.0	1.5	4.8	4.5	3.3	2.3
5. I.P.C. 6 lb.	2.0	1.8	4.0	2.0	2.5	3.0
6. Dacthal 6 lb.	3.0*	1.8	5.0	4.3	2.8	2.5
7. Dacthal 10½ lb.	3.8**	1.8	5.0	4.5	3.8	2.5
8. TOK E-25 6 lb.	4.3**	2.5	5.0	4.8	4.5	4.3
9. Dymid 6 lb.	2.0	1.8	2.8	4.0	3.5	3.5
10. Prefar 4 lb. (soil incorporated)	1.0	1.0	1.0	1.0	1.0	2.0
11. I.P.C. 6 lb. (soil incorporated)	1.0	1.3	5.0	1.5	2.5	2.5
12. Treflan 2 lb. (soil incorporated)	1.0	1.5	4.5	4.0	2.0	2.8
13. Trefmid W-50 7 lb. (soil incorporated)	1.5	1.8	4.3	4.3	4.0	3.0
14. Treflan 4 lb.	2.8*	1.8	4.8	4.8	2.3	2.8
L.S.D. 5% (1%)	1.0(1.4)	n.s.	0.9(1.2)	1.1(1.5)	1.5(2.0)	1.6(2.2)

[1] Crop Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete.
[2] Weed Rating: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
*Significantly different from the cultivated check at the 5% level (**1% level).

EXPERIMENT NO. 11

(Permanent file copy WC–81A)
Lalamilo Branch Station Field 3

Crop:	Lettuce 'Early Great Lakes.'
Experimental design:	Randomized complete block, 4 replications, plot size 5 ft. x 30 ft. (2 rows per plot).
Experimental procedure:	Field preparation May 24, 1965; Soil-incorporated treatments May 25; Seed sown May 25; Pre-emergence sprays applied May 26; Treatment No. 16 applied on June 10 as an over-the-plant spray.
Climatic conditions:	*Rainfall (over .1 inch)*: June 4–.16 inch, 6–.1, July 11–.8.
	Irrigation (Overhead): May 27–.5 inch, thereafter applied as needed.
Results:	See Table A-11.

Discussion and Summary:

Crop tolerance: Dacthal was the only treatment that injured lettuce when applied immediately after seed sowing as compared to no injury when sprayed over the plants at 2 weeks.

Weed control: The control of purslane was commercially acceptable with the pre-emergence sprays of Dacthal, C.I.P.C., Vegadex, and Treflan 2 lb/acre; also, the soil incorporated 2 lb/acre application of Treflan. Smooth amaranth was controlled satisfactorily with Treflan 2 lb/acre and Dacthal at sowing. The poor control of swinecress with all of the herbicides was discouraging.

TABLE A-11. Lettuce tolerance and weed control response to the herbicides,[1] Lalamilo Branch Station, Experiment No. 11 (July 2–5 weeks)

Treatment (pounds active per acre)	Lettuce Tolerance[1]	Weed Rating[2]		
		Purslane	Amaranth	Swine-cress
1. Check, uncultivated	1.0	1.0	1.0	1.0
2. Check, cultivated	1.0	4.0	4.3	4.3
3. Balan 1 lb. soil incorporated	1.0	1.5	1.5	1.5
4. Balan 1¼ lb. soil incorporated	1.0	1.5	1.8	1.0
5. Balan 2½ lb. soil incorporated	1.0	3.5	3.3	1.8
6. Balan 2½ lb.	1.0	2.8	3.0	1.5
7. Treflan ¾ lb. soil incorporated	1.0	3.3	3.0	1.3
8. Treflan 1 lb. soil incorporated	1.0	2.5	2.5	1.8
9. Treflan 2 lb. soil incorporated	1.0	4.0	4.0	2.5
10. Treflan 2 lb.	1.8	3.8	3.8	1.8
11. Vegadex 6 lb. soil incorporated	1.0	3.8	3.5	2.5
12. C.I.P.C. 6 lb. soil incorporated	1.0	3.5	2.0	1.8
13. C.I.P.C. 6 lb. soil incorporated	1.5	4.5	3.0	2.5
14. Prefar 8 lb. soil incorporated	1.0	1.3	1.3	1.0
15. Dacthal 10½ lb.	4.0	5.0	5.0	1.8
16. Dacthal 10½ lb. at 2 weeks	1.3	4.0	3.5	1.5
L.S.D. 5%	0.2	0.8	0.8	1.1
L.S.D. 1%	0.3	1.1	1.1	1.4

[1] Lettuce tolerance: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
[2] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete.

EXPERIMENT NO. 12

(Permanent file copy 81–F)
Lalamilo Branch Station Field 4

Crop:	Chinese Cabbage 'Nagaoka 60 days.'
Experimental design:	Randomized complete block, 4 replications, plot size 2½ ft. x 20 ft.
Experimental procedure:	Field preparation May 24, 1965; Balan incorporated May 25; Seed sown May 25; Pre-emergence applications May 27.
Climatic conditions:	*Rainfall (over .1 inch)*: June 4–.16 inch, 6–.1, July 11–.8.
	Irrigation (Overhead): May 27–.5 inch, thereafter applied as needed.
	Air temperatures: May 27–64°to 66° F.
Results:	See Table A-12.

Discussion and Summary:

Crop tolerance: No crop injury was observed with the chemicals tested.

Weed control: Dacthal and Vegadex at the high rates were the only herbicides which showed some control of smooth amaranth. The other weed results were somewhat variable and no statistically significant differences were measured. The high rates of Vegadex and Dacthal again showed indications of fair control of purslane and swinecress.

TABLE A-12. Chinese Cabbage tolerance and weed control ratings recorded for the various species, Lalamilo Branch Station, Experiment No. 12

Treatment (pounds active per acre)	Chinese Cabbage Tolerance[1] July 2	Weed Rating[2] July 2 (5 weeks)		
		Smooth Amaranth	Purslane (Pigweed)	Swine-cress
1. Check, uncultivated	1.0	1.0	1.8	1.0
2. Check, cultivated	1.0	3.0	2.8	2.5
3. Vegadex 4 lb.	1.0	2.0	3.0	3.0
4. Vegadex 6 lb.	1.0	3.3	3.8	3.5
5. Dacthal 6 lb.	1.0	2.3	2.3	2.0
6. Dacthal 10½ lb.	1.3	3.5	3.8	3.8
7. Balan 2½ lb. (soil incorporated)	1.0	2.3	3.0	2.8
8. R-7465 6 lb.	1.0	2.0	3.8	2.0
L.S.D. 5% (1%)	n.s.	1.4(1.8)	n.s.	n.s.

[1] Crop Rating: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
[2] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete control.

EXPERIMENT NO. 13

(Permanent file copy 81–D)
Lalamilo Branch Station Field 2

Crop:	Daikon 'Minoyonbai-Long.' Daikon 'Chinese Half-Long.'
Experimental design:	Randomized complete block, 4 replications, split plot arrangement of treatments–herbicides 2½ ft. x 30 ft., 15 ft. of each variety–subplot.
Experimental procedure:	Field preparation May 24, 1965; Treflan soil incorporated May 25; Seed sown May 25; Pre-emergence applications May 27.
Climatic conditions:	*Rainfall (over .1 inch)*: June 4–.16 inch, 6–.1, July 11–.8. *Irrigation (Overhead)*: May 27–.5 inch; thereafter applied as needed. *Air temperatures*: May 27–64° to 66° F.
Results:	See Table A-13.

Discussion and Summary:

Crop tolerance: Moderate phytotoxicity was observed on the 2 daikon varieties treated with Lorox and Sinox PE. Vegadex, Dacthal, Caparol, Treflan, and Dymid showed no evidence of daikon injury. The latter results were encouraging for a good herbicide is needed for use with daikon in the Islands.

Weed control: Treflan, Lorox, and Caparol were the most satisfactory as regards control of purslane and smooth amaranth.

TABLE A-13. Daikon tolerance and weed control ratings, Lalamilo Branch Station, Experiment No. 13 July 2 (5 weeks)

Treatment (pounds active per acre)	Daikon tolerance[1]		Weed Rating[2]	
	Long	Half-long	Purslane (Pigweed)	Smooth Amaranth
1. Check, uncultivated	1.0	1.0	1.5	2.0
2. Check, cultivated	1.0	1.0	4.0	4.3
3. Vegadex 6 lb.	1.0	1.0	4.3	3.3
4. Dacthal 10½ lb.	1.0	1.0	3.0	3.5
5. Caparol 4 lb.	1.3	1.0	4.3	3.8
6. Lorox 2 lb.	3.3**	3.0**	4.8	4.5
7. Sinox PE 6 lb.	2.5**	3.0**	3.3	2.0
8. Treflan 2 lb. (soil incorporated)	1.0	1.0	4.5	4.5
9. Dymid 6 lb.	1.0	1.0	3.5	3.3
L.S.D. 5%	0.7	0.8	1.4	1.0
L.S.D. 1%	1.0	1.1	1.9	1.3

[1] Crop Rating: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
[2] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete control.

*Significantly different (Daikon tolerance only) from the cultivated check at the 5% (**1% level).

EXPERIMENT NO. 14

(Permanent file copy WC–84)
Manoa Campus Farm Field K–3

Crop: Lettuce 'Green Mignonette.'

Experimental design: Randomized complete block, 3 replications, plot size 10 ft. x 15 ft.

Experimental procedure: Field preparation July 26, 1965; Soil incorporated treatments applied on July 26; Lettuce sown July 26; Pre-emergence treatments applied on July 27; Lettuce resown on August 2, 1965.

Climatic conditions: *Rainfall (over .1 inch)*: August 4–.16 inch, 5–.12, 6–.17, 7 to 9–.43, 10–.47, 14 to 16–.28, 17–.43, 18–.17, 21 to 23–.65, 25–.22, 28 to 30–.28, September 1–.14, 13–.61.

Irrigation (Overhead): July 27–.5 inch; thereafter applied as needed.

Results: See Table A-14.

Discussion and Summary:

Crop tolerance: Vegadex and Balan did not injure the lettuce which was resown 1 week after treatment application. The injury incurred with Treflan appeared severe early in the growing cycle; however, the lettuce showed fair recovery at 7 weeks after treatment.

Weed control: Treflan resulted in excellent weed control at the rates tested. Balan performed slightly better than the standard herbicide, Vegadex, but neither herbicide exhibited commercially acceptable weed control under the test conditions.

TABLE A-14. Lettuce tolerance and weed control response to the herbicides, Manoa Campus Farm, Experiment No. 14

Treatment (pounds active per acre)	Lettuce Tolerance[1] (7 weeks)	Weed Response: No. of Weeds/sq. ft. (3½ weeks)			Weed Response: Subjective Rating[2] (7 weeks)	
		Wiregrass	Purslane	Spiny Amaranth	Wiregrass	Purslane
1. Check, uncultivated	3.3	38.0	73.0	9.0	1.0	1.0
2. Check, cultivated	1.7	0	0	0	2.0	2.0
3. Vegadex 6 lb.	1.3	4.0	4.3	2.3	2.7	2.7
4. Balan 1 lb. (soil incorporated)	1.7	2.6	7.6	1.3	3.7	3.7
5. Balan 1¼ lb. (soil incorporated)	1.3	2.1	4.6	0	2.3	2.7
6. Balan 2½ lb. (soil incorporated)	1.7	1.3	1.3	0	3.3	3.7
7. Balan 2½ lb.	1.3	0.3	2.0	0.6	3.3	3.7
8. Treflan 1 lb. (soil incorporated)	2.7	0	0	0	5.0	5.0
9. Treflan 2 lb. (soil incorporated)	3.3	0	0	0	4.3	5.0
10. Treflan 2 lb.	2.7	0	0.6	0	4.0	3.7
L.S.D. 5%	0.9	3.6	7.8	1.7	1.3	1.2
L.S.D. 1%	1.3	4.9	10.7	2.4	1.8	1.6

[1] Lettuce Tolerance: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.
[2] Weed Rating: 1–no control, 2–slight, 3–fair, 4–good, 5–complete.

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